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A longitudinal study of the adoption of IT technology in the Swedish building sector

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ABSTRACT

The rapid development of IT technology has in the past decades created opportunities for faster and more efficient processes, and new working methods in the building industry. This paper presents the results of a longitudinal survey-based study (the "IT barometer") of IT use in the Swedish building industry, conducted at several intervals over the period 1998–2011. The results show a rapid increase in general IT use, and in the use of sector-specific tools. Improving communication and information sharing is a strong driving force for taking IT into use, for instance technologies such as EDM and EDI, although the adoption of the more complex applications (ie BIM) is slower. Interestingly "demands from employees" has over the years become a very important reason for companies to increase their IT use. Leading areas for planned IT investments include document handling and mobile equipment, with BIM technology rather low on the list.

1. Introduction

1.1. Background and purpose

In recent decades IT has provided completely new ways to communicate, consume media, and perform services via governments and banks, to name a few examples. It has also had a tremendous impact on how both industrial and service companies conduct their business. Also within the building sector, IT has helped to change the way we manage information, communicate, and to some extent change the processes and practices.

In light of this, there is a need for research regarding what types of IT tools are used in the industry, how they are used, what effects on productivity and quality they have as well as what perceptions industry stakeholders have of IT. This has been deemed interesting from several perspectives. Continuous measurement of IT use, effects and prospects gives the research community the opportunity to make analysis and draw conclusions about how different IT innovations contribute to increased productivity and efficiency in the sector, as well as areas in which further research is required. Also organizations funding R&D can benefit in the planning of new funding programs. The results of such research also provide businesses with the opportunity to benchmark and make evaluations of completed and planned IT investments. The IT sector and software vendors can also use research results as support for decisions about how they should adapt their products and services to fit their needs of the industry.

In addition to the need for more empirical data on the IT-development in the sector we also recognized already from the start of the project the need to develop a rigorous method for conducting the study so that the results are representative for the industry and the average company. This was because many case studies and studies using convenience samples for instance using email lists of R&D programs are reported in journal articles, conference papers and presentations, and often such results tend to give an overly optimistic view of the use of advanced technologies. Our hope from the start was that other researchers would copy and adapt the same method we have used.

This article describes the use over a period of more than one decade of the survey tool "The IT Barometer" [1–4], a questionnaire that has been used, in whole or in selected parts, by in least 11 countries during the last decade [5] and thus allows for cross-country as well as longitudinal comparisons. This article aims in particular to describe the results of the fourth "IT barometer survey" in Sweden, which was performed in the spring of 2011, as well as to compare the results with the earlier studies. The quantitative study has also been supplemented with a qualitative interview-based study focusing on the adoption mechanisms of EDM, EDI and BIM technologies [6].

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The purpose of each phase of the IT Barometer survey has been to describe the current situation of IT use and its effects in the building sector, and through comparison with previous studies, analyze trends over time. The building sector is in this study is defined as contractors, architects, technical consultants, property owners and the material industry. This paper presents the results from a fourth measurement of IT use in the sector, and also provides a short review of similar studies conducted in other countries.

1.2. IT-barometers and similar surveys

The Project IT-barometer was initiated in the late 1990s and early 2000 as part of a national R&D program (IT BoF 2002) with the main purpose of measuring and following up the development of IT use in the Swedish construction sector. The purpose was also to create a method that could not only be repeated in Sweden, but also be used for international comparisons. An early collaboration between the Nordic countries resulted in surveys where the same questionnaires were used in Sweden, Finland and Denmark. Comparisons of the results are reported in [7,2,8].

The method has since then been disseminated and used in other countries, with minor or major variations to the questions, depending on country variations and the different objectives and boundaries of each individual survey. These surveys are shortly described below, divided in three groups:

1. Surveys that extensively have used the IT barometer tool
2. Other studies with similarities to the IT barometer
3. Studies where the results of IT barometer surveys are used for analyses.

1.3. Surveys that have extensively used the IT barometer tool

The first survey performed outside of the Nordic region was done in Canada [9], where large parts of the tool were used and where the author also contributed significant improvements to the survey design and the questions, which then have been used in future survey iterations. Other countries where IT-barometer surveys has been carried out, in its entirety or in selected parts, are: New Zealand [10,5], Singapore [11,12], where a quantitative comparison with the Nordic countries was made; Nigeria [13], where an IT barometer study was performed also with the purpose to evaluate questionnaires as a method to also collect qualitative data; Indonesia [14] where a less extensive, modified barometer has been used, but with sufficient similarities to provide a basis for some comparisons; Malaysia [15]; Taiwan [16] and Turkey [17].

1.4. Other studies with similarities to the IT barometer

In Jordan a variant of the IT barometer has been used with a particular focus on the relationship between IT adoption and job satisfaction [18]. A survey in the south eastern United States used a similar survey methodology and developed the qualitative results of a regression analysis between IT use and firm performance [19]. Some studies have chosen to focus on a specific actor or certain tools. For example Chien [20] examines the use of I-Build technology i.e. IT tools for construction related business, and its impact on efficiency. Irlayici and Tas [21] focus on the strategic level of IT use by contractors. A special focus on BIM and its benefits and costs are presented in a study by Becerik–Gerber and Rice [22], and the use of IT in SMEs in building construction is described by Acar et al. [23].

1.5. Studies where results of IT barometer surveys have been used for analyses

Michaloski and Paula [24] analyzed several barometer surveys and studied the technical, cultural and overall dimensions of IT. Ugwu and Kumaraswamy [25] used a similar survey as part of a method in a study of success factors for construction ICT projects, where it is combined with qualitative deductive analysis and case studies. Gaith, Khalim, and Ismail [26] performed an extensive literature review of a big number of studies with the purpose to clarify relationships between investments in IT and overall performance of companies in the construction industry. The review uses several of the performed IT barometers together with other surveys. Another literature review of ICT use in construction is made by Zietsman [27], which includes a classification of different research themes in the area, where 99 articles has been studied. Arif and Karam [28] present both a local survey with much similarity to the IT barometer, and an attempt to international comparisons between countries where barometer surveys has been performed. Conclusions were drawn for the areas General IT usage, Use of CAD and Use of Networks, among architects.

2. The IT-barometer survey instrument

To be able to measure the IT use in the industry over time a valid method had to be developed that could be repeatable and comparable over time. Much effort was therefore put into development of the method before the first survey was performed. This was done in 1997 and the method is thoroughly described in a master degree thesis [1], and also more briefly in [2]. The method is summarized in this section.

A number of choices have to be made, when performing a survey with satisfactory validity and reliability. The most important, which are described below, are: definition of *target population*; selection of *source for the population*; selection of categories to present, *stratification*; selection of data collection format, *type of survey*; and *weighting* of answers to correct for stratification.

2.1. Target population and source for selection

The target population was defined as all companies in Sweden working as architects, technical consultant (within the construction, civil engineering, and property management sector), contractors, property managers and also the construction material sector. There were a few possible registries that cover these categories of companies, and an evaluation of these resulted in a choice to use Statistics Sweden (SCB) [29] as source since they keep a directory containing all companies in Sweden, categorized in a detailed way.

The SCB directory is updated every 3 months. It is possible to make the selection either on the basis of companies, or on the basis of workplaces, where workplace is defined as “each address, property or group of contiguous properties where the company carries out activity” [29]. The selection was made on the basis of workplaces for two main reasons. Firstly, many companies work with more than one type of business. Some workplaces can belong to multiple company categories and can thus use IT to a different extent and in different ways. Secondly, if a large company should be represented by only one questionnaire, this would cause some disproportion in the results, since it is weighted according to the number of employees. By choosing workplaces as a basis for selection, the possibility of getting a more detailed and true description of reality is increased.

2.2. Stratification

The statistical method chosen was stratified free random selection. “Stratified” means that the population is divided into a number of separate groups based on specific pre-defined characteristics. A free random selection is then used to make the selection of units within these groups. In this selection each unit in the population has the same probability to be part of the selection. This method using two steps is necessary if the survey is to be able to say something about parts of the industry. Otherwise it is only possible to make statements about the industry as a whole. It was decided that the study should be able to make statements partly about the industry as a whole, partly